High-Energy X-rays for Characterizing Complex Materials

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XPD, the high energy (≥ 40 keV) X-ray Powder Diffraction three-endstation beamline at NSLS-II, is ideal to house an optimized set-up for the diamond anvil cell (DAC) program and a 1,000 ton uniaxial press for the multi-anvil cell (MAC) program. A secondary focusing optics is being implemented that will provide a 5x10 mm^2 beam, sufficiently small to allow for efficient laser heating in a DAC experiment, but large enough to allow quantitative analysis of powder diffraction patterns. Moreover the combination of laser-heating or resistive heating in a DAC and MAC will extend the pressure and temperature range, enabling studies of P, T equations-of-state, phase transitions, reactions between minerals, melting in minerals, compression behavior, stability field, etc. The DAC limits by design the access to the reciprocal space; however, high energy X-rays allow to partially overcome this restriction and measure a larger amount of the reciprocal space, which results in more precise and reliable parameters in structure solving and refining of the sample, be a powder, a single-crystal or a liquid. The MAC will also offer the opportunity to analyze "spotty" diffraction patterns through a multi-grain approach - *e.g.* 3D-XRD for grain mapping and grain dynamics at high P,T - and to potentially combine tomographic imaging and diffraction experiments in the 10MPa stress – 10^{-5} strain range for studies of rheology, elasticity, anelasticity, or kinetics. This gives the program at XPD a distinct advantage for investigating the atomic structure of crystalline, disordered, nanocrystalline, amorphous or liquid Earth material in Extreme Conditions, compared to other established high pressure diffraction beamlines.